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PAPERS ON CEREAL AND FORAGE INSECTS.

THE LEGUME POD MOTH.
THE LEGUME POD MAGGOT.

BY

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THE LEGUME POD MOTH.

(*Etiella zinckenella schisticolor* Zell.)

By James A. Hyslop,
Agent and Expert, Cereal and Forage Insect Investigations.

HISTORICAL.

The first mention of the legume pod moth (*Etiella zinckenella schisticolor* Zell.) as of economic importance in the United States is found in the unpublished notes of Mr. Theodore Pergande [1] in the files of the Bureau of Entomology, and refers to a number of lima-bean pods sent in by Mr. Albert Koebele from Eldorado County, Cal., on July 21, 1885. The larvæ were reported as doing considerable damage to the bean crop in that region. They left the pods and, if not full grown, entered other pods to continue feeding or, if full grown, constructed slight cocoons in the bottom of the rearing jar and pupated. Adults emerged September 2 and September 15.

A similar reference,[2] from the same source, refers to a number of pods of *Crotolaria incana* collected by Mr. E. A. Schwarz at Cocoanut Grove, Fla., on May 9, 1887, and sent to the Bureau of Entomology. The larvæ were eating the seed, and from these on May 16 an adult emerged. From a second lot of seed pods from the same source received on June 1, three more moths emerged on the 24th.

On May 2, 1896, a number of pods of *Astragalus* sp. were received by the bureau from Mr. C. L. Marlatt,[3] the material having been collected at Neucestown, Tex., infested with larvæ of *Etiella zinckenella*. On May 13 a braconid parasite issued, and on June 5 an adult moth emerged.

A single specimen was received from Mr. E. E. Bogue,[4] of Stillwater, Okla., on August 17, 1896, which he had previously reared from the seed pod of *Crotolaria sagittalis*.

Dr. F. H. Chittenden,[5] of this bureau, has published a paper on this insect in which the records made by Mr. H. O. Marsh are incor-

[1] Bureau of Entomology Notes, No. 3819.
[2] Bureau of Entomology Notes, No. 4129.
[3] Bureau of Entomology Notes, No. 7044.
[4] Bureau of Entomology Notes, No. 7173.
[5] Bul. 82, Pt. III, Bur. Ent., U. S. Dept. Agr., p. 25, 1909.

porated. Mr. Marsh found the larvæ attacking lima beans at Santa Ana, Garden Grove, Anaheim, and Watts, in California. At Garden Grove they had destroyed 40 per cent of the crop.

SYNONYMY AND DISTRIBUTION.

The species *Etiella zinckenella* was described by Treitschke [1] in 1832, and the variety *E. zinckenella schisticolor* was described as *E. schisticolor* in 1881 by P. C. Zeller [2] from two specimens, a male and a female, collected from "very different parts of North America." The male was from California and was collected October 8, but of the female he has nothing to say. He also refers to specimens of *E. zinckenella* examined by him from Sierra Leone, West Africa; Madagascar; Honda, Colombia, South America; and "Carolina" in this country. Later Rev. G. D. Hulst [3] redescribed this species under the name *Etiella villosa*, and gave Colorado and Califorina as the habitat. Dr. H. G. Dyar in his catalogue gives Arizona as an addition to the habitat.

The typical *E. zinckenella* is represented in the National Museum collection by specimens from Hampton, N. H.; Weekapong, R. I.; Key West and Archer, Fla.; Oxbow, Saskatchewan; Texas; Stillwater, Okla.; and Denver, Colo. The variety *E. zinckenella schisticolor* is represented by specimens from Stockton, Utah; Springfield, Idaho; Eldorado, Clairmont, Alameda, and San Diego, Cal.; Nogales, Ariz.; and Pullman, Wash. It will be noted that all the specimens of the variety were collected west of or in the Rocky Mountains.

Etiella zinckenella schisticolor differs very slightly from the typical form. It has a suffusion of gray scales on the primaries as its chief distinctive character. A number of specimens from Florida, one specimen from Rhode Island, and one from New Hampshire very closely resemble the European specimens of *E. zinckenella*.

A possible explanation of the above facts may be that the variety *schisticolor* is a native of the Pacific slope of this continent, while the forms found in the eastern United States are the typical *E. zinckenella* recently introduced into this country from the Old World or South America.

FOOD PLANTS.

Larvæ of *Etiella zinckenella* have been recorded as feeding on the seed of several species of leguminous plants. In California (Eldorado County) Mr. A. Koebele [4] found them doing considerable damage to lima beans and they were recently found by Mr. H. O. Marsh,[5] of this bureau, working on the same crop in that State. Mr. E. E.

[1] Die Schmetterlinge von Europa, von Friedrich Treitschke, 9 Band, p. 201, 1832.
[2] Horæ Societatis Entomologicæ Rossicæ, vol. 16, p. 177, 1881.
[3] Ent. Amer., vol. 3, p. 133, 1887.
[4] Bureau of Entomology Notes, No. 48 K.
[5] Bul. 82, Pt. III, Bur. Ent., U. S. Dept. Agr., p. 25, 1909.

Bogue [1] found the larvæ in the seed pods of the common rattlebox (*Crotolaria sagittalis*) at Stillwater, Okla., and Mr. E. A. Schwarz [2] found them in the pods of a tropical species of this genus (*Crotolaria incana*) at Cocoanut Grove, Fla. Mr. C. L. Marlatt [3] records finding the larvæ in the seed pods of milk vetch (*Astragalus* sp.). They are also recorded by Herrich-Schäffer [4] as feeding in the seed pods of *Spartium junceum* near Vienna, Austria.

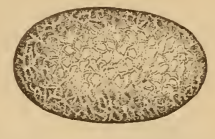

FIG. 28.—The legume pod moth (*Etiella zinckenella schisticolor*): Egg. Greatly enlarged. (Original.)

During 1910 and 1911 the author reared the species from the pods of common lupines (*Lupinus* spp.) and Canada field peas at Pullman, Wash.

DESCRIPTION.

THE EGG.

(Fig. 28.)

Egg glistening white, bluntly elliptical in outline and circular in cross section, measuring 0.58 mm. in length and 0.31 mm. in diameter. Chorion very delicate, colorless, and with fine irregular corrugations on the surface.

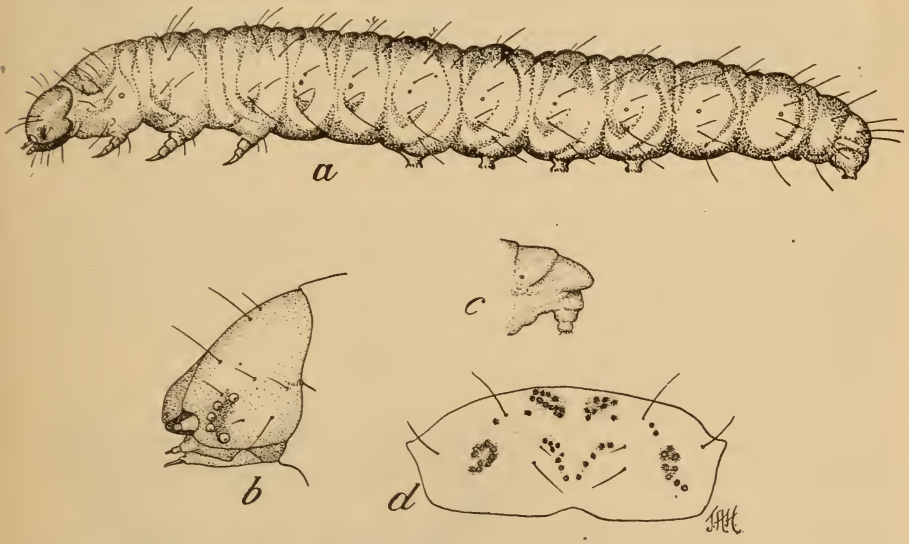

FIG. 29.—The legume pod moth. Larva: *a*, Side view; *b*, lateral aspect of head; *c*, caudal segments; *d*, pronotal shield. *a*, Enlarged; *b*, *c*, *d*, greatly enlarged. (Original.)

THE LARVA.

(Fig. 29.)

Full-grown larva from 12 to 17 mm. in length and from 2.5 to 3.5 mm. in diameter. Head yellow, black patch over ocellar area; mandibles and tip of labrum black; five ocelli arranged in an anteriorly directed semicircle at base of antennæ. Dor-

[1] Bureau of Entomology Notes, No. 7173.
[2] Bureau of Entomology Notes, No. 4129.
[3] Bureau of Entomology Notes, No. 7044.
[4] Syst. Bearb. der Schmett. von Europa, vol. 4, p. 72, 1849.

sum ruddy pink, except the pronotum (immature larvæ are evenly pale green or cream colored, with head and pronotal shield black or brown), the pleural and ventral surfaces pale green or cream white. Head pale yellow. Tips of thoracic legs and head brownish yellow. Five pairs of prolegs situated on segments 3, 4, 5, 6, and 9; the last pair can be retracted, so as to be almost invisible. Pronotum yellowish, with brown or black markings as follows: Two medial pairs of dot patches, the posterior pair nearly touching the posterior margin and somewhat oblong in outline, the anterior pair approaching the anterior margin and linear in outline, being for the most part made up of a single row of dots; both pairs converging anteriorly, the anterior rows forming a V. Posterior margin bearing four bristles. Two pairs of bristles flanking the anterior median patches of dots, the posterior bristle in each pair short.

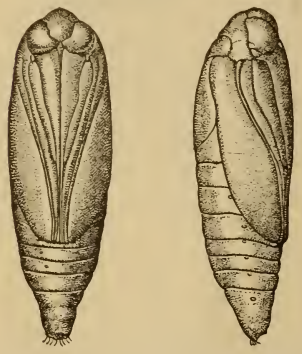

FIG. 30.—The legume pod moth: Pupa. Greatly enlarged. (Original.)

THE PUPA.

(Fig. 30.)

Pupa from 6 to 10 mm. in length, amber-yellow, with the tip of the abdomen, the edges of the abdominal segments, and margins of the wings outlined in brown. Fourth, fifth, and sixth abdominal segments each bearing a pair of short spines on the ventral surface. Abdominal segments 2 to 9 bearing well-defined brown spiracles. Terminal abdominal segment provided with a transverse row of 6 hooked bristles and a pair of lip-shaped tubercles on its dorsal surface.

THE ADULT.

(Fig. 31.)

"The adult expands 24–27 mm. Labial palpi russet-gray above, gray below. Maxillary palpi yellowish, brown on end. Head, collar and fore-thorax orange fuscous. Thorax behind fuscous gray. Abdomen fuscous; fore wings mouse color, consisting of bluish gray, overlaid partly with fuscous. A broad white stripe extending from base along costa to apex. Extreme edge of costa of ground color broadening outwardly just beyond middle and fading away toward apex. A dull yellowish basal stripe reaching from white costal stripe to inner margin, edged inwardly with a row of maroon-brown scales, the scales being longer than usual. Hind wings fuscous, deepening outwardly, with dark marginal line. Beneath even glistening, very light fuscous." (Hulst, Trans. Amer. Ent. Soc., vol. 17, p. 170, 1890.)

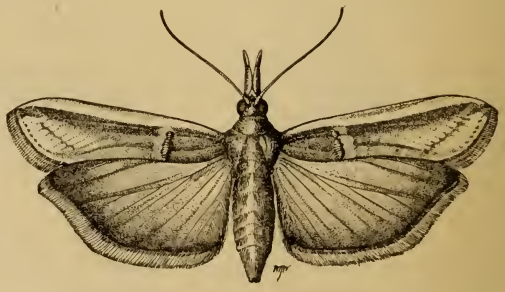

FIG. 31.—The legume pod moth: Adult. Enlarged about 2½ diameters. (Original.)

SEASONAL HISTORY.

On July 26, 1911, an eggshell was found on the outer surface of the calyx of a well-filled though still green lupine seed pod. The larva, which had evidently emerged only a few minutes before it was dis-

covered, measured 1.2 mm. in length and was found just inside the pod at the terminus of a burrow which led from just in front of the egg through the calyx and pod wall. The hole through which the larva emerged from the eggshell was terminal, round, and very neatly cut. A few days later two eggs were found on the calcyces of field peas; these were brought into the insectary but failed to hatch.

During late July and early August, 1911, larvæ in all stages of development, from very small specimens, evidently just hatched, to those which were mature and spinning cocoons, were found in both the pods of field peas and lupines. The larvæ on first emerging are pale green or cream colored, the pronotal plate and head being entirely black or brown; with the first molt the pronotal plate assumes the characteristic pattern described elsewhere in this paper, but the body does not assume the rosy tint as described until nearly mature.

The larvæ feed for about three weeks, only partly consuming the peas, as is seen in figure 32, destroying them as seed, besides greatly reducing their weight as stock feed. The pod always contains a mass of frass held together by a loosely constructed web. The larva will leave one pod and enter another if the food supply is exhausted, or if for any other reason the pod becomes uninhabitable. When mature, if the peas are still unharvested in the field, it emerges from the pods and enters the ground to pupate, or if the pods have been harvested it spins a tough silken cocoon in the nearest available sheltered place.

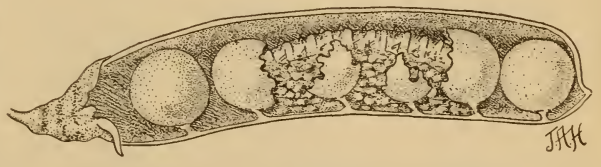

FIG. 32.—The legume pod moth: Larva feeding in a pod of field pea. Enlarged. (Original.)

Larvæ that become mature during the warm weather of early August, out of doors, or later under laboratory conditions, pupate immediately and emerge as adults in about six weeks. Adults have been obtained in our laboratory on August 5 and as late as August 28. Whether these lay eggs which pass the winter successfully, or whether they hibernate as adults, is still undetermined. Larvæ that reach maturity in late September, when the nights are cold, spin their cocoons and hibernate therein as larvæ, pupating in the spring and emerging at the time the earliest lupines are setting seed.

On the lupines there are very probably two generations a year. The moths of the first generation, coming from hibernating larvæ, lay all their eggs on the lupines, as the field peas are just commencing to grow. The offspring of this generation mature late in July and, finding the field peas ripening, very naturally turn their attention to these large areas of suitable food as well as to their natural food, the later lupines.

Mr. C. L. Marlatt [1] reared adults on June 5, 1896, from larvæ that were collected May 2 of that year at Nuecestown, Tex. Mr. Albert Koebele [2] reared adults on September 2 and 15, 1885, from larvæ collected June 21 at Rattlesnake Bridge, Eldorado County, Cal. Mr. Koebele also noticed the entrance holes of young larvæ and the exit holes of older larvæ in the pod husks. He says, "The larvæ * * * spun a web on the bottom of the jar in which they pupated."

Mr. Theodore Pergande [3] received a number of larvæ from Mr. E. A. Schwarz collected at Cocoanut Grove, Fla., on May 9, 1887, and on May 26 reared an adult from this material. More material from the same source was received on June 1, and on the 24th three more adults emerged.

Mr. H. O. Marsh obtained adults from January 9 to February 25, 1909, from larvæ collected October 22, 1908, at Anaheim, Cal.[4]

These observations indicate that two generations a year is characteristic of this species, the adults of the first appearing in early June and those of the second in September. The adults obtained in January and February were reared under laboratory conditions, which very probably accelerated their development. In the more southern parts of its range this species may have more than two generations.

FIELD WORK.

July 21, 1909, while examining the seed pods of the common lupine (*Lupinus* sp.) many were found to contain lepidopterous larvæ. In such pods the seeds were always more or less destroyed. The pods also contained a mass of frass which was held together by a loosely constructed web. A few days later, on examining the collected material, several of the pods were found with newly eaten holes in the sides and two larvæ were found with half their bodies within fresh pods.

On August 7 one of the larvæ, very plump, was found still in the pod, it having in the meantime become suffused with a rosy color. This larva had constructed a loose silken cocoon, through which its body could be easily seen. Ten days later the larva pupated and emerged as an adult (*Etiella zinckenella schisticolor*) September 28.

In the rearing cages with solid bases most of the larvæ left the seed pods and spun their cocoons among the litter and dirt in the bottom of the cages. In cages with bottoms of earth the larvæ always burrowed 2 or 3 inches below the surface to pupate.

On August 1, 1910, Mr. M. W. Evans, of the Bureau of Plant Industry, told the author of a larva that he was finding in the field-pea

[1] Bureau of Entomology Notes, No. 7044.
[2] Bureau of Entomology Notes, No. 48 K.
[3] Bureau of Entomology Notes, No. 4129.
[4] Bul. 82, Pt. III, Bur. Ent., U. S. Dept. Agr., p. 25, 1909.

pods in his experimental plats at Pullman, Wash. On examining some of these larvæ it was found that they resembled those of *Etiella zinckenella schisticolor* that had been found in lupine-seed pods the previous year, differing only in being larger, measuring about 17 mm. in length, while those from lupine measured only 13 mm., due, without doubt, to the difference in food plant.

The following day a number of the larvæ were collected from the field-pea pods and placed on earth in a flowerpot, into which they immediately burrowed.

From a larva placed in a pill box an adult emerged on August 27 and on the same day two moths emerged from the earth in the flowerpot.

EXPERIMENTAL WORK CARRIED ON DURING THE SEASON OF 1910.

In the spring of 1910 the Bureau of Plant Industry planted over 100 varieties of field peas at Pullman, Wash. These were planted

FIG. 33.—The work of the legume pod moth (upper row) compared with that of the pea weevils (Bruchidæ) (lower row). Enlarged. (Original.)

in plats 1 rod square, in order to study development and adaptability of the various varieties under semiarid conditions. Mr. M. W. Evans has very kindly permitted the use of his field notes, and of the crop when harvested from these plats, which has greatly facilitated this investigation. These notes indicated the time of planting, the time the first flowers of each variety came into bloom, the time of maximum blooming, and the time of last blossoms. The seed harvested from each plat was kept in individual packages.

By actual count the writer determined the percentage of damage to each variety of field peas by these moths. The "worms" do not usually consume the entire seed, but so far destroy it as to render germination impossible. Seed thus damaged is easily distinguished from that attacked by Bruchus. The latter makes a very smooth round exit hole, while the former gnaws into the seed very irregularly. (See fig. 33.)

Figure 34 is a plan of the experimental plats and shows very clearly that the attacks of the pod moth were not restricted to any one part of the field, but were more or less promiscuously distributed. The plantings were made on a gentle slope, the upper side being to the south, thus giving a northerly exposure. The vacant rectangle in the center of the plan indicates a wheat-straw stack. All sides of the field were bounded by grain fields, and the roadside was practically

				1	2	3	4	5	6	7	8	9	10
			11	12	13	14	15	16	17	18	19	20	21
22	23	24	25	26	27	28	29	30	31	32	33	34	35
36	37	38	39	40	41	42	43	44	45	46	47	48	49
50	51	52	53	54	55	56	57	58	59	60	61	62	63
64	65	66	67						68	69	70	71	72
73	74	75	76			STRAW STACK			77	78	79	80	81
82	83	84	85						86	87	88	89	90
91	92	93	94	95	96	97	98	99	100	101	102	103	104
105	106	107	108	109	110	111	112	113	114	115	116	117	118
119	120	121	122	123	124	125	126	127	128	129	130	131	132
133	134	135	136	137	138	139	140	141	142	143	144	145	146
147	148	149	150	151	152	153	154	155	156	157	158	159	160

FIG. 34.—Planting plan of plats used in investigations of the legume pod moth during the season of 1910. (Original.)

without weeds of any kind. The plats were separated from each other by strips of oats 1 yard in width.

Field peas vary greatly in texture of the seed, time of blooming, time of maturing seed, and adaptability to semiarid conditions. The variability, however, is confined to the varieties to a large extent, the individuals of a variety being quite uniform in response to given conditions. This fact at once opened the question of a worm-resistant variety. The results arrived at by this investigation are very suggestive. The actual records made in the investigation are to be found in Table I, but to make the results more readily available the

variations in percentage of damage under several variables are graphically illustrated by diagrams.

TABLE I.—*Record of experimental work on the legume pod moth for the season of 1910.*

Plat No.	B. P. I. No.	Began blooming.	Full bloom.	Blooming ended.	Total number of seed.	Number of seed damaged.	Per cent damaged.
51	21289	June 14	June 17	July 6	21,802	0	0.0
97	24177	June 16	June 21	...do....	14,098	11	.0
102	21288	June 17	June 23	July 9	19,920	0	.0
26	11097	...do....	June 21	July 12	7,506	0	.0
20	11112	...do....	June 23	...do....	24,722	15	.0
43	22639	June 19	June 24	...do....	9,010	0	.0
46	24895	...do....	June 25	...do....	13,828	10	.0
31	24179	...do....	June 26	...do....	19,508	8	.0
59	22077	June 14	June 21	July 14	14,517	0	.0
2	23331	June 21	June 26	July 16	6,662	2	.0
100	22007	June 16	.....	July 17	15,484	4	.0
$\frac{1}{10}$ acre	20466	June 28	July 1	...do....	22,117	4	.0
8	22036	June 23	...do....	July 24	15,539	14	.0
16	21709	June 26	...do....	...do....	24,581	11	.0
101	21605	June 10	June 16	July 3	26,431	36	.1
4	23290A	June 26	July 1	July 7	11,781	21	.1
63	22638	June 10	June 17	July 12	30,276	36	.1
149	23525	June 19	June 26	...do....	10,500	20	.1
5	22640	June 26	July 1	July 26	13,625	25	.1
150	23290H	July 1	July 6	.....	19,413	33	.1
72	17006	.....	...do....	Aug. 3	23,707	37	.1
19	18455	June 24	July 1	July 14	11,310	30	.2
32	24178	June 21	.....	July 22	12,694	31	.2
73	24940	...do....	June 26	...do....	13,063	28	.2
70	20467	June 26	June 30	...do....	18,495	45	.2
42	24262	June 16	June 23	July 17	9,792	33	.3
48	19389	June 23	June 28	July 24	22,960	80	.3
13	22040	July 1	July 9	Aug. 3	19,039	65	.3
41	17486	June 26	July 3	July 24	13,252	66	.4
7	22045	...do....	July 6	July 26	14,522	72	.4
55	12888A	June 30	...do....	.....	10,477	43	.4
10	19786	...do....	July 3	July 26	11,939	59	.4
103	20382A	...do....	July 6	July 29	20,335	85	.4
44	19290	June 19	June 24	July 6	3,346	21	.6
17	21290	June 21	June 30	July 17	22,372	136	.6
54	16439	June 23	.....	...do....	24,937	169	.6
148	23547	June 26	June 30	.....	14,585	95	.6
49	17483	June 30	July 6	July 26	33,529	229	.6
104	19788A	...do....	...do....	.....	16,509	107	.6
61	16437	June 26	...do....	July 29	9,350	63	.6
35	22043	...do....	...do....	July 26	20,588	145	.7
14	22038	July 3	...do....	...do....	20,255	145	.7
98	23850	June 19	June 26	July 17	13,971	138	.9
76	18456	June 23	...do....	.....	13,639	131	.9
25	16130	...do....	July 1	Aug. 3	2,279	21	.9
80	10274A	July 9	July 17	Aug. 14	10,290	122	1.1
56	12887	June 26	June 30	July 22	9,848	119	1.2
87	23851	...do....	...do....	July 24	21,895	292	1.3
60	17483A	June 28	July 6	Aug. 3	9,400	127	1.3
90	20381	July 17	July 24	Aug. 13	8,887	118	1.3
69	23847	June 28	July 6	Aug. 3	19,007	302	1.5
58	22078	June 23	.....	July 24	8,444	164	1.9
160	16436	June 24	June 30	July 22	18,724	382	2
37	22044	July 1	July 9	Aug. 3	18,555	411	2.2
12	22041	July 3	July 12	July 26	12,053	278	2.3
77	19787	July 2	July 9	.....	14,699	389	2.6
82	19709	July 3	July 14	Aug. 9	14,713	387	2.6
15	22037	...do....	July 9	July 26	22,148	683	3
40	19785	June 26	July 6	...do....	10,447	346	3.3
159	16437A	June 28	...do....	...do....	7,105	244	3.4
36	22046	July 1	...do....	...do....	11,191	391	3.4
38	22042	July 3	July 9	...do....	13,822	502	3.6
88	22049	...do....	...do....	July 29	23,573	893	3.7
99	23848	June 26	July 3	Aug. 3	15,066	563	3.7
$\frac{1}{10}$ acre	16819	July 3	July 9	...do....	6,581	281	4.2
156	17483E	July 9	July 14	July 29	10,732	821	7.6

The diagram, figure 35, shows the maximum (solid line) and minimum (dotted line) percentage of seed damaged in all varieties which commenced blooming at any given time. It shows that varieties

which began blooming during and after the last week in June were decidedly the most severely attacked.

Figure 36 shows similar data on all varieties in full bloom at any given time, besides very clearly showing that such varieties as were in full bloom between the first and last weeks of July were the most severely attacked.

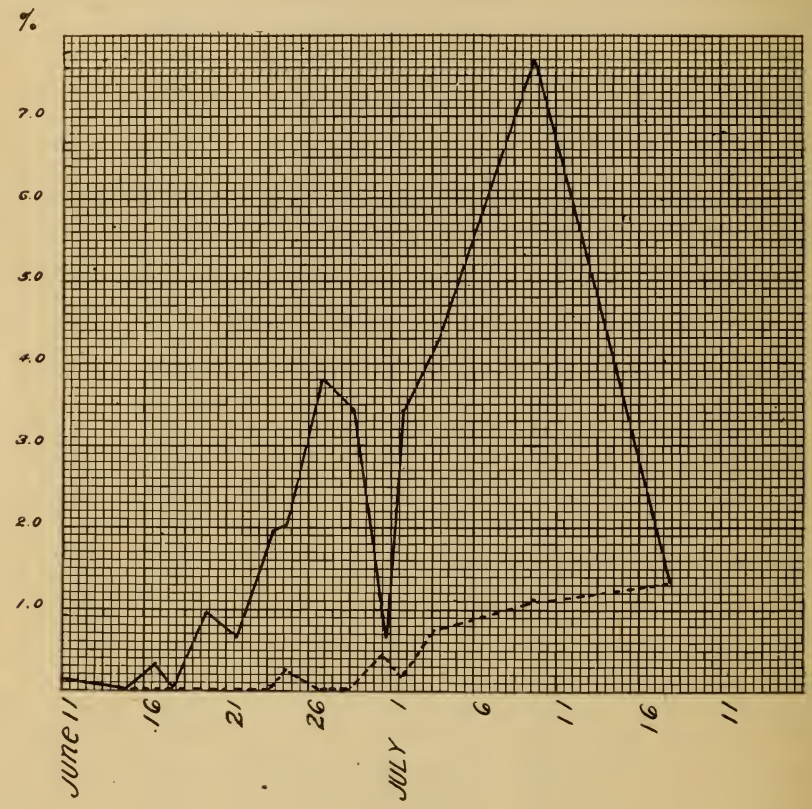

FIG. 35.—Diagram showing maximum and minimum damage done by the legume pod moth to varieties of peas commencing to bloom on a given date in 1910. (Original.)

Figure 37 shows similar data on all varieties which ceased blooming on any given date, and indicates that such varieties as had ceased blooming before the middle of July were only slightly damaged.

As the time the plants are in full bloom is very evidently of the greatest significance, Table II and figure 38 were arranged to show the mean percentage of damage done to all varieties in full bloom at any given time, which indicates very conclusively that varieties which were in full bloom from the 1st to the middle of July are by far the worst damaged by the legume pod moth.

TABLE II.—*Mean percentage of damage done by the legume pod moth to all plats in full bloom on a given date in the season of 1910.*

Date of full bloom.	Mean per cent of seed damaged.	Number of plats.	Date of full bloom.	Mean per cent of seed damaged.	Number of plats.
June 16	0.1	1	July 1	0.2	7
June 17	.1	2	July 3	2.1	2
June 21	.0	3	July 6	1.1	15
June 23	.1	3	July 9	2.5	8
June 24	.3	2	July 12	2.3	1
June 25	.0	1	July 14	5.1	2
June 26	.4	6	July 17	1.1	1
June 28	.3	1	July 24	1.3	1
June 30	1.0	6			

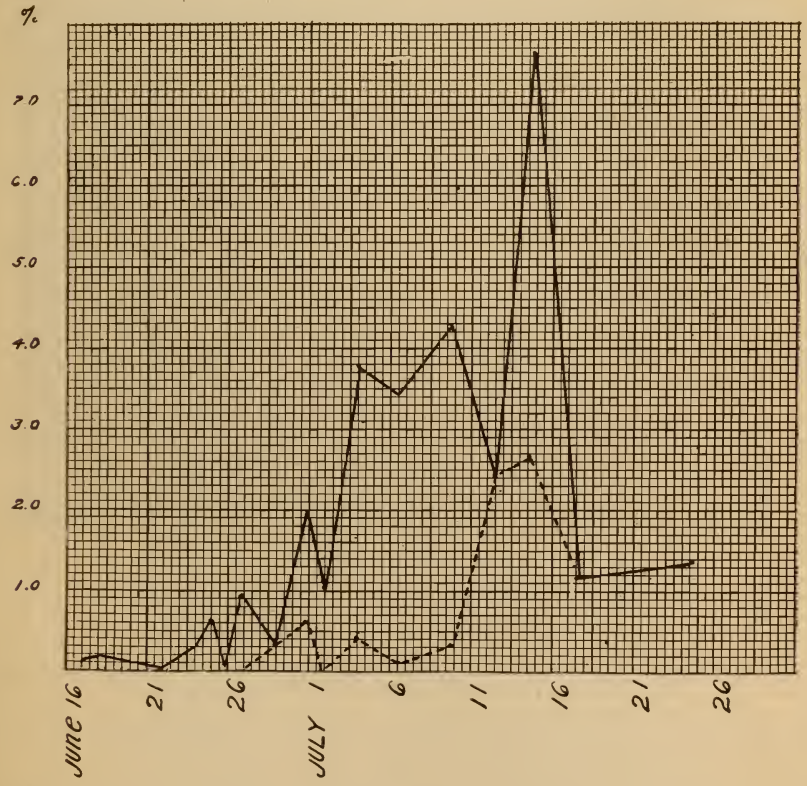

FIG. 36.—Diagram showing maximum and minimum damage done by the legume pod moth to varieties of peas in full bloom on a given date in 1910. (Original.)

EXPERIMENTAL WORK CARRIED ON DURING THE SEASON OF 1911.

Sixty-seven varieties of field peas were planted in 1911 on the farm of the State College at Pullman, Wash. The field selected was in a draw, or ravine, bordered on three sides by grain fields and on

the fourth side by a clean cultivated orchard. The plats were 1 square rod in area, as they were the year before, and separated from each other by strips of oats 1 yard wide. Two plats of each variety were planted side by side. (See fig. 39.) Plate X shows a part of the experimental plats used this season. The moths were not quite so destructive this season as last, 2.5 per cent being the greatest damage done to any variety this year, while in 1910 as high as 7.6 per cent

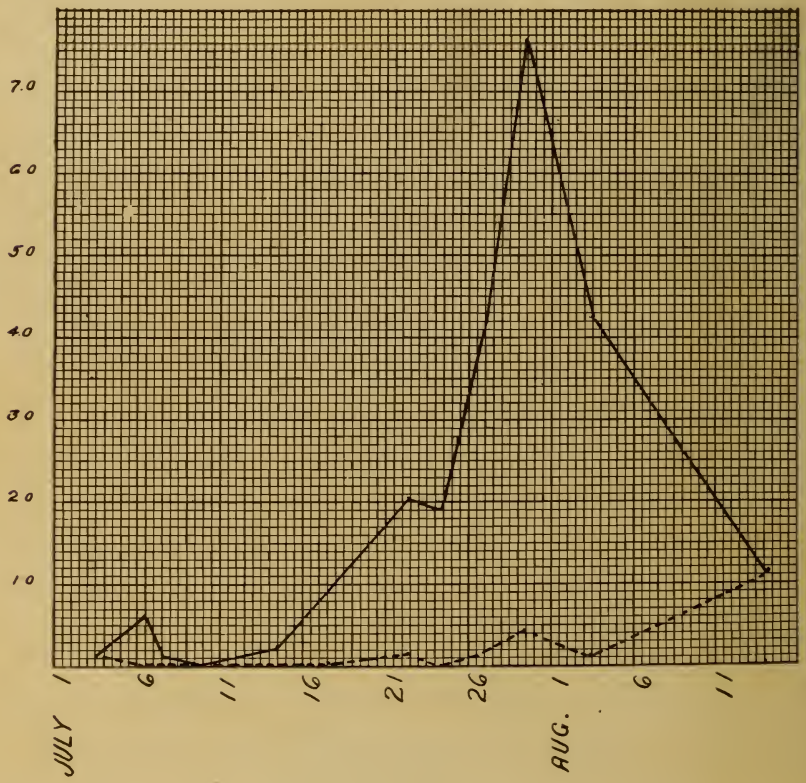

FIG. 37.—Diagram showing maximum and minimum damage done by the legume pod moth to varieties of peas which ceased to bloom on a given date in 1910. (Original.)

of one variety was destroyed. However, the results obtained are as conclusive as those recorded last year.

Table III gives the data of this season's work and is self-explanatory. Table IV is arranged to show the mean percentage of damage done to all plats which came into full bloom on any one date. Figure 40 graphically illustrates these results and very clearly shows that varieties which were in full bloom prior to June 28 were practically unmolested.

EXPERIMENTAL PLATS USED IN INVESTIGATIONS OF THE LEGUME POD MOTH DURING THE SEASON OF 1911. (ORIGINAL.)

TABLE III.—*Record of experimental work on the legume pod moth for the season of 1911.*

Plat No.	B. P. I. No.	Date of planting.	Began blooming.	Full bloom.	Blooming ended.	Total number of seed.	Number of seed damaged.	Per cent damaged.
1	24895	Apr. 15	June 17	June 28	July 15	9,400	0	0.0
2	29366	...do.....	June 7	June 12	July 7	33,529	0	.0
3	22639	...do.....	June 16	June 19	July 15	23,797	5	.0
5	18806	...do.....	...do.....	...do.....	July 7	2,279	2	.0
12	29368	Apr. 17	June 22	June 28	July 15	28,417	7	.0
38	22638	Apr. 18	June 12	June 16	...do.....	19,899	4	.0
57	21288	...do.....	June 19	June 28	...do.....	22,462	8	.0
65	3182	...do.....	June 22	...do.....	...do.....	15,745	9	.0
4	17483B	Apr. 15	June 25	July 8	July 30	18,725	20	.1
8	23850	...do.....	June 16	June 28	July 21	16,380	18	.1
14	23547	Apr. 17	June 22	...do.....	July 15	19,725	21	.1
6	22540	Apr. 15	June 19	July 8	July 21	10,290	24	.2
21	23290D	Apr. 17	...do.....	July 3	July 15	22,823	46	.2
9	22044	Apr. 15	June 28	July 15	Aug. 1	14,463	104	.7
17	22043	Apr. 17	...do.....	July 13	July 29	8,416	68	.8
20	23414	...do.....	June 26	July 7	July 15	16,279	131	.8
30	29372	...do.....	June 19	June 28	...do.....	8,726	88	1.0
52	23290H	Apr. 18	June 28	July 10	...do.....	8,909	90	1.0
58	19389	...do.....	June 22	July 7	...do.....	10,080	101	1.0
10	17486	Apr. 15	June 28	...do.....	July 21	13,772	161	1.1
13	29365	Apr. 17	July 12	July 15	Aug. 1	21,795	242	1.1
39	25439	Apr. 18	June 28	July 7	July 21	20,224	223	1.1
56	24179	...do.....	June 19	July 1	July 10	13,406	148	1.1
62	11097	...do.....	...do.....	June 28	...do.....	31,369	377	1.2
59	24940	...do.....	June 22	July 5	July 15	22,259	268	1.2
54	23290E	...do.....	June 28	July 7	July 21	24,165	290	1.2
51	22049	...do.....	.....	July 15	...do.....	12,514	151	1.2
47	21709	...do.....	June 22	June 28	July 15	3,235	42	1.3
48	22077	...do.....	June 12	...do.....	...do.....	14,303	201	1.4
34	16130	Apr. 17	June 28	July 8	July 26	22,857	320	1.4
44	16436A	Apr. 18	.....	July 7	July 21	10,226	154	1.5
22	22037	Apr. 17	July 12	July 15	Aug. 1	19,761	299	1.5
23	17483	...do.....	July 7	July 13	July 30	12,814	193	1.5
63	11112A	Apr. 18	June 16	July 7	July 23	13,164	211	1.6
19	17006	Apr. 17	July 7	July 12	July 21	14,352	243	1.7
43	22042	Apr. 18	...do.....	July 15	Aug. 1	11,828	201	1.7
26	22046	Apr. 17	.....	...do.....	July 30	13,141	224	1.7
16	29369	...do.....	June 26	July 7	July 15	10,112	184	1.8
31	2203	...do.....	July 7	July 13	July 21	15,373	277	1.8
35	22036	...do.....	June 26	July 7	...do.....	20,868	376	1.8
67	11112	Apr. 18	June 19	...do.....	July 15	16,234	294	1.8
28	29367	Apr. 17	June 24	...do.....	...do.....	9,399	188	2.0
42	21290	Apr. 18	...do.....	July 5	...do.....	14,588	292	2.0
33	29371	Apr. 17	June 28	July 7	July 21	26,239	527	2.0
46	25917	Apr. 18	July 7	July 15	...do.....	22,859	457	2.0
66	3179	...do.....	.....	July 10	July 26	13,599	272	2.0
61	22048	...do.....	July 7	July 15	Aug. 1	19,140	383	2.0
11	22639A	Apr. 17	June 28	July 7	July 21	9,277	199	2.1
18	17483F	...do.....	July 12	July 15	...do.....	15,379	323	2.1
24	29323	...do.....	June 22	July 7	July 15	13,528	285	2.1
27	19786	...do.....	.....	...do.....	July 25	10,621	223	2.1
36	27003	...do.....	July 7	July 13	July 26	22,266	468	2.1
40	16437A	Apr. 18	June 28	July 7	July 21	8,776	185	2.1
53	12887	...do.....	...do.....	...do.....	July 15	29,165	613	2.1
60	22041	...do.....	July 7	July 13	July 25	20,366	428	2.1
55	29370	...do.....	...do.....	July 15	...do.....	7,333	162	2.2
49	23847	...do.....	...do.....	...do.....	July 21	18,206	401	2.2
45	20467	...do.....	June 28	July 7	...do.....	14,602	322	2.2
25	19788	Apr. 17	July 7	July 15	Aug. 1	11,209	259	2.3
50	27004	Apr. 18	...do.....	...do.....	July 27	10,370	239	2.3
64	3184	...do.....	June 28	July 5	July 15	14,933	359	2.4
41	22040	...do.....	July 7	July 13	July 21	16,498	397	2.4
15	17483C	Apr. 17	...do.....	July 15	Aug. 1	1,871	45	2.4
32	26819	...do.....	.....	July 18	...do.....	24,470	612	2.5
29	19787	...do.....	July 7	July 15	...do.....	15,473	387	2.5
7	19709	July 15	.....	...do.....	...do.....	7,506	192	2.6
37	16436C	July 18	June 28	July 7	July 21	21,791	557	2.6

TABLE IV.—*Mean percentage of damage done by the legume pod moth to all plats in full bloom on a given date in the season of 1911.*

Full bloom.	Mean per cent of seed damaged.	Number of plats.	Full bloom.	Mean per cent of seed damaged.	Number of plats.
June 12	0.0	1	July 7	1.7	19
June 16	.0	1	July 8	.6	3
June 19	.0	2	July 10	1.5	2
June 28	.5	10	July 12	1.7	1
July 1	1.1	1	July 13	1.8	6
July 3	.2	1	July 15	1.9	15
July 5	1.9	3	July 18	2.5	1

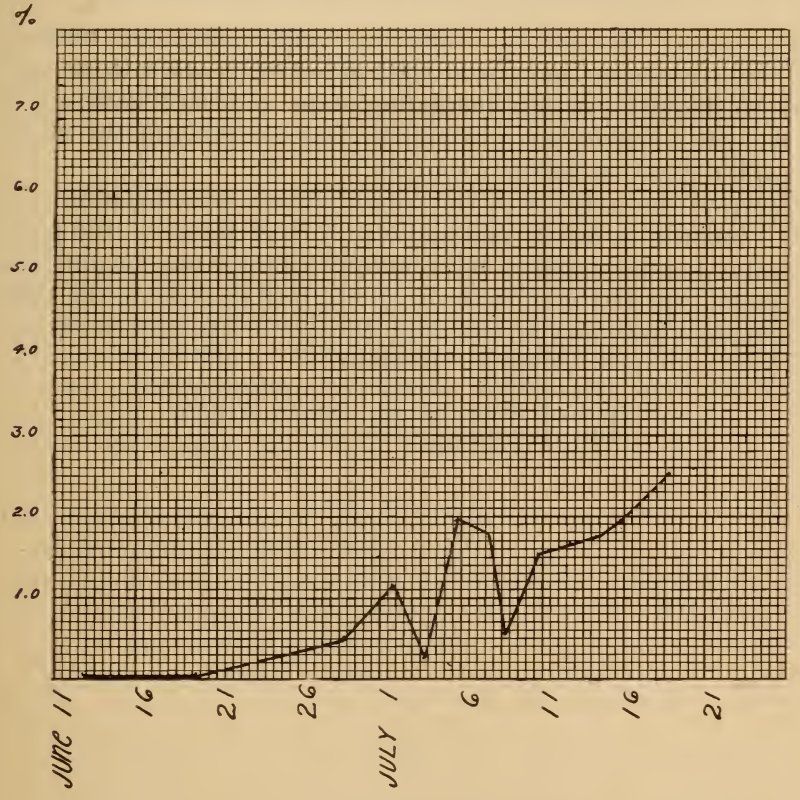

FIG. 40.—Diagram showing mean percentage of damage done by the legume pod moth to varieties of peas in full bloom on a given date in 1911. (Original.)

ARTIFICIAL DISSEMINATION.

On examining sacks of seed peas, September 14, 1911, a larva was found enclosed in a very tough silken cocoon. On October 24 another larva was found in a second sack. Mr. Evans also found a hibernating larva in a seed sack and kept it alive on his desk during the greater part of the winter. It seems as if this insect could very easily be introduced into regions where it does not at present occur, by being shipped with the seed field peas.

PARASITES.

Two hymenopterous parasites were reared from the larvæ of *Etiella zinckenella schisticolor* during the investigations at Pullman, Wash., viz, *Pseudapanteles etiellæ* Vier. and *Microbracon hyslopi* Vier.

Dr. F. H. Chittenden [1] records having reared *Bracon* sp. (determined by Viereck) from *Etiella schisticolor* on October 19, 1908, at Santa Ana, Cal., and Mr. C. L. Marlatt [2] records rearing a braconid from the larva of this moth at Nuecestown, Tex., on May 13, 1896.

REMEDIAL AND PREVENTIVE MEASURES.

The legume pod moth is readily controlled by preventive measures, and for this reason there have been no experiments with remedies. The transportation of the hibernating forms in sacks of seed, and the consequent dissemination of the pest, may be prevented by fumigation of the seed with carbon bisulphid.

Owing to the presence of the native lupines, extermination of the pest is impossible, but by planting such early varieties of field peas as come into full bloom before the last week in June it may be practically eliminated as a factor to be dealt with in seed growing in the Pacific Northwest. The date of planting, however, will vary in different localities and under different conditions.

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[1] Bul. 82, Pt. III, Bur. Ent., U. S. Dept. Agr., p. 28, 1909.

[2] Bureau of Entomology Notes, No. 7044.

THE LEGUME POD MAGGOT.

(*Pegomya planipalpis* Stein.)

By James A. Hyslop,
Agent and Expert.

GENERAL ACCOUNT.

About the middle of July, 1909, a large number of larvæ of *Pegomya planipalpis* Stein were found leaving the pods of lupines that had been placed in rearing cages. On the 28th two pupæ were found in one of the cages. Within the next few days many more larvæ left the pods and pupated. A number of these puparia placed in a glass vial during the autumn of 1910 were kept in the field laboratory all winter. May 11 of the following year the first adult emerged and from that date others emerged daily throughout the remainder of the month. By a number of experiments it was found that humidity greatly facilitated the emergence of these flies.

These flies were first believed to be scavengers, feeding on the frass and decaying seed of the lupine and field peas in the wake of the legume pod moth. However, investigations in 1910 proved that the insect, though often found with Etiella, was quite capable of independently infesting seed pods and was itself an actual seed destroyer. Many pods were found to contain from one to three of these larvæ.

Dr. F. H. Chittenden,[1] of this bureau, notes this species as attacking radishes at San Francisco, Cal.

The larvæ molt at least twice, as two pairs of pharyngeal hooks were found in a pod with one larva. Though several of these dipterous larvæ were found in field-pea pods with the head capsules of larvæ of the legume pod moth, we hardly believe this species to be parasitic, as larvæ confined in small vials with pod-moth larvæ would not attack the latter.

In cages with earth in the bottom the pupæ were always to be found below the surface at distances ranging from 1 to 3 inches. The larvæ contract just before forming a puparium. The puparium is at first creamy yellow, turning brown at the ends first and finally becoming entirely ferruginous. A larva that contracted on the morning of July 31, 1911, assumed the usual puparium form by 9.30 a. m. of the same day. It was still pale yellow, but by 2.30 p. m. it had become brownish at the ends and deep orange-yellow at the middle, while next morning the puparium was uniformly ferruginous brown.

[1] Bul. 66, Pt. VII, Bur. Ent., U. S. Dept. Agr., p. 95, 1909.

DESCRIPTION.

THE LARVA.

(Fig. 41.)

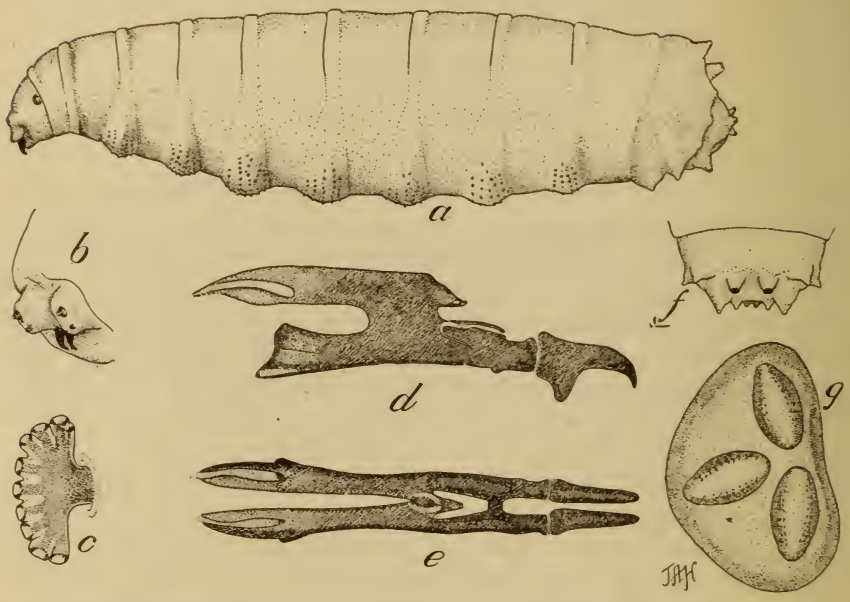

FIG. 41.—The legume pod maggot (*Pegomya planipalpis*). Larva: *a*, Side view; *b*, oblique aspect of head; *c*, thoracic spiracle; *d*, *e*, pharyngeal hooks, lateral and dorsal aspect; *f*, dorsal aspect of caudal segment; *g*, anal spiracle. *a*, Much enlarged; *b–g*, highly magnified. (Original.)

Larva cream-white, 7.9 mm. in length and 1.9 mm. in diameter. Broadly blunt posteriorly, conically tapering to anterior end. Hook jaws black. At base of second thoracic segment a pair of fan-shaped thoracic spiracles which are pale yellow and ten-lobed. Anal spiracles on rather long papilliform tubercles; spiracular orifices of each spiracle three in number and arranged to form a letter T, the stem directed laterad and slightly ventrad. Four small tubercles below the spiracles are arranged in a row across the end of the caudal segment, the outer pair the larger. In front and to the side of this row is a pair of larger tubercles and in front of this pair is a ring of twelve tubercles around the segment; the two dorso-lateral and the two ventro-lateral tubercles large and conspicuous, the others smaller. Ventral swellings on segments 3 to 9, inclusive, armed with many small spinous papillæ.

FIG. 42.—The legume pod maggot: Puparium. Much enlarged. (Original.)

THE PUPARIUM.

(Fig. 42.)

Puparium ferruginous, dark brown at ends. Cylindrically oval, finely wrinkled. Hook jaws of larva visible. Length 6.4 mm.; width 2.3 mm.

THE PUPA.

(Fig. 43.)

White, head large, front protruding. Legs and wing pads free. Third pair of legs under wing pads except tarsi.

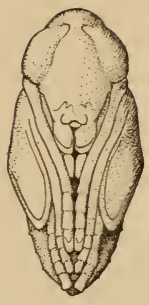

FIG. 43.—The legume pod maggot: Pupa. Much enlarged. (Original.)

THE ADULT.

(Fig. 44.)

The following is a translation of the original description by P. Stein, published in the Berliner Entomologische Zeitschrift, volume 42, page 234, 1897.

Pegomya (*Chortophila*) *planipalpis.* ♂ ♀. Size, shape, and color similar to *Ch. cilicrura* Rd. Cinereous; eyes cohering closely on inside, frontal triangular stripe practically straight, reddish; front and epistoma laterally moderately prominent, cinereo-rufous, peristome moderately broad, grayish; antennæ black, third joint twice as long as second, base of arista thickened, very slightly pubescent,

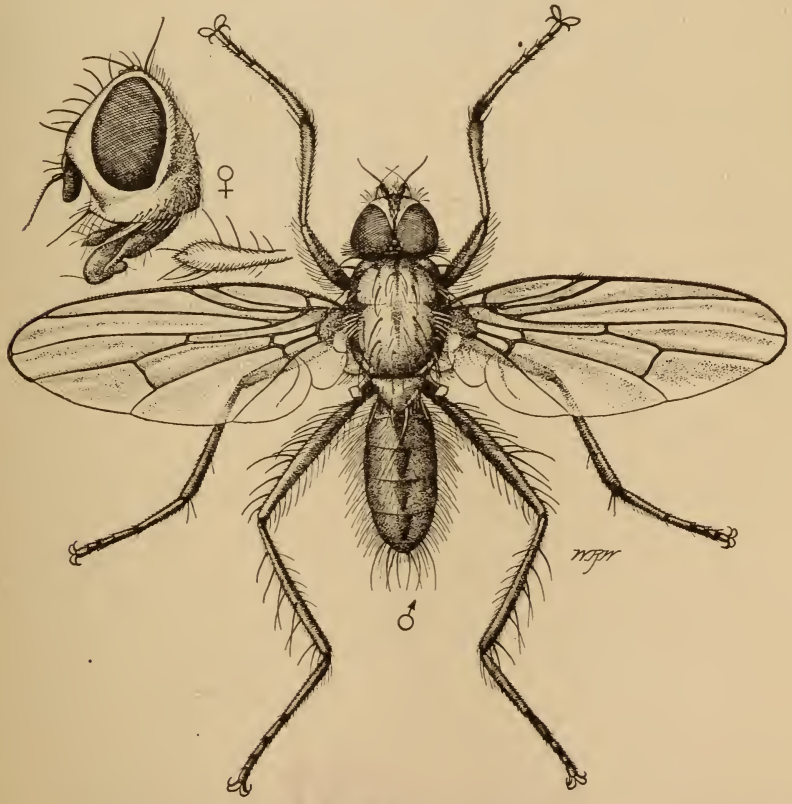

FIG. 44.—The legume pod maggot: Adult male, enlarged; side of head of female, much enlarged. (Original).

palpi black, apex a little dilated; thorax cinereous, less so on the sides, median line narrow and lateral stripes hardly perceptibly wider; abdomen elongate, depressed, median stripe and incisures narrowly black; tarsi black; pulvilli and ungues, the

anterior ones moderately and the posterior one slightly, elongate; wings nearly hyaline, longitudinal veins 3 and 4 parallel, anterior cross-vein perpendicular and nearly straight, costal spines small; squamæ equal and white, halteres yellowish. Female yellowish-gray; eyes with frontal stripe broad, dirty reddish, and quite broadly separated with yellowish gray; palpi distinctly dilated at apex; thorax nearly immaculate; abdomen oblong, median stripe and small areas shining indistinct yellowish brown; base of wings yellowish. Size ♂ 5, ♀ 6 mm.

PARASITES.

Pegomya planipalpis is attacked by two chalcidid parasites. One (*Holaspis* n. sp.) belongs to a genus of which there are two known species, *Holaspis parellina* Boh. and *H. papaveris* Thoms., recorded [1] as parasitic on *Cecidomyia* spp. The other parasite (not yet determined) reared from the legume pod maggot is probably also new to science.

REMEDIAL AND PREVENTIVE MEASURES.

This maggot has not as yet become a serious factor in field-pea seed growing in the Pacific Northwest. The dissemination as hibernating puparia can be readily prevented by fumigation. As is the case with the legume pod moth, it can not be exterminated because of the native lupines.

[1] Dalla Torre, Catalogus Hymenopterorum, vol. 5, p. 291, 1898.

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